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ABSTRACT

This study examined variables which may be important in the design of instructional environments adapted to accommodate individual differences. Purposes of the study were: (1) to determine whether matching or mismatching subjects with their tendency toward field dependence or field independence had any effect on achievement in a hypermedia learning environment; (2) to determine whether matching or mismatching subjects with their tendency toward field dependence/independence had any effect on satisfaction; (3) to examine the role of awareness of field dependence/independence and the resulting effect on achievement; (4) to examine the role of awareness of field dependence/independence and the effect on satisfaction; and (5) to explore possible interactions of these variables (awareness of cognitive style, field dependence/independence, and match/mismatch) with cognitive style. Students (n=177) enrolled in instructional technology courses were administered the Group Embedded Figures Test to determine field dependence/independence. Half of the students were made aware of their cognitive style. Participants were taught Hypercard, using a treatment that either matched or mismatched their cognitive style, and were then required to complete their own Hypercard stacks. Empirical results indicated that awareness of cognitive style and matching/mismatching with instruction embedded with support for cognitive style did not make a difference for this sample. (Contains 22 references.) (Author/AEF)

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# The Role of Awareness of Cognitive Style in Hypermedia

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Jennifer B. Summerville
Emporia State University

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## Abstract

*The focus of this dissertation was to examine the variables of cognitive style, subject awareness of the instructional implications of cognitive style and matching/mismatching subjects with cognitive style. These variables may be important in the design of instructional environments, such as hypermedia, adapted to accommodate individual differences.*

## Introduction

Individual differences are becoming a focus of current instructional design and practice. It is unrealistic, however, to expect teachers in all educational settings to alter educational environments in order to meet each student's educational needs such as differences in cognitive style. Some of the responsibility for learning must rest with the learner.

Currently, many students are unaware of how knowledge of their own individual differences, such as field dependence/independence, affect the ways in which they learn (Jones, 1993). The focus of this study is to examine some of the critical variables which may be important in the design of instructional environments adapted to accommodate individual differences.

Matching cognitive style to teaching environments may be important because of the potential to enhance learning. However, at this time, the relationship between matching cognitive styles and learning has not been researched fully and the implications are inconclusive, especially for hypermedia learning environments.

This researcher hypothesized that hypermedia could be designed to capitalize on a student's tendency for field dependence or field independence and also designed to compensate for any learning difficulties field dependent/independent students may encounter due to their tendency. In the past, researchers have concentrated on variables other than those directly related to field dependence/independence which may have confounded their results.

Based on the review of the literature, this researcher believed that one of the main problems with studies that match and mismatch subjects with their own cognitive style was that the variable of awareness of cognitive style had not been taken into consideration. Not including this variable presented some potential problems. For example, the subject may be aware of his or her "style" preference prior to the treatment, especially in the case of learning styles and environmental preferences. As a result, mismatching the subjects to learning styles other than their own could possibly alter learning outcomes. In contrast, the subject may be unaware of his or her "style" preference and the potential importance of this preference prior to the treatment, again altering learning outcomes.

## Purpose of the Study

There were several purposes for this study. The first was to determine whether matching or mismatching subjects with their tendency toward field dependence or field independence had any effect on achievement in a hypermedia learning environment. A second purpose, related to the first, was to determine whether matching or mismatching subjects with their tendency toward field dependence or field independence had any effect on satisfaction in a hypermedia learning environment. The third purpose was to examine the role of awareness of field dependence/independence as students learned in a hypermedia environment and the resulting effect on achievement. The fourth was to examine the role of awareness of field dependence/independence as students worked in a hypermedia environment and the effect on satisfaction. The final purpose was to explore possible interactions of the variables: awareness of cognitive style, field dependence/independence, and match/mismatch with cognitive style in a hypermedia environment.

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## Statement of the Research Questions

The following research questions and hypotheses guided this study.

1. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

2. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

3. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

4. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

5. To what extent does awareness of field dependence/independence affect student achievement in a hypermedia Hypercard lesson?

6. To what extent does awareness of field dependence/independence affect student satisfaction with a hypermedia Hypercard lesson?

7. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence), singly or in combination, affect achievement in learning Hypercard?

8. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence), singly or in combination, affect satisfaction with the Hypercard lesson and the learning experience?

## Significance of the Study

Kogan (1971) proposes that, "Witkin's field dependence/independence dimension would appear to be ideally suited for research on the interaction between variables of cognitive style and instructional treatment. Both ends of Witkin's dimension have adaptive properties, though of a distinctly different kind, and it is feasible that educational programs could be devised to profit each of the polar types" (p. 252).

The combination of identifying cognitive style, instructional treatment supported by design features related to the cognitive style characteristics and learner awareness of cognitive style may prove to have significant impact on student achievement on a given task and/or student satisfaction with that task.

This researcher examined variables identified as important for future research in other studies. Specifically: (a) determining whether or not field dependence/independence can, or should, be embedded within a hypermedia environment; (b) discovering what role awareness of cognitive style plays in achievement and satisfaction with a hypermedia learning environment; and (c) defining which interactions between variables hold the most potential for increasing achievement and satisfaction.

## Definition of Terms

The following terms with the stated definitions were used extensively throughout this study.

Awareness of Cognitive Style - The degree to which an individual understands the instructional implications of specific cognitive style characteristics.

Field Dependence/Independence - The degree to which an individual's processing of information is effected by the contextual field.

Matching Instructional Environments - Instructional environments designed to match a student's cognitive style--in this case, field dependence/independence.

Mismatching Instructional Environments - Instructional environments designed to be mismatched with a student's cognitive style--in this case, field dependence/independence.

Satisfaction - The degree to which students are satisfied with the learning environment, are comfortable with the learning environment, and perceived that they learned from the experience.

## Literature Review

### Field Dependence/Independence

This researcher chose to begin with the most comprehensive literature review of field dependence/independence (Witkin et al., 1977) and the Manual for the Embedded Figures Tests (Witkin, Ottman, Raskin, & Karp, 1971) because of their extreme importance in setting both a theoretical and practical foundation. Witkin and colleagues (1977) detailed the research done in the area of field dependence/independence over twenty-five years. Field dependence/independence appears to affect many aspects of daily life including the ability to learn from social environments, types of educational reinforcement needed to enhance learning, amount of structure preferred in an educational environment, cue salience, interactions between teachers and students, and career choices.

However, despite the plethora of research detailed by Witkin and his colleagues (1977), these researchers noted additional areas for further research. Many of the suggestions were in the area of interactions between field dependence/independence and the characteristics of the learning environment. It is unknown whether some of the behaviors exhibited by teachers during research experiments are due to the characteristics of field dependence/independence or whether these behaviors are in fact due to the Hawthorne Effect, an observed change in research participants' behavior based on their awareness of participating in an experiment (Borg, Gall, & Gall, 1996).

Another question raised by Witkin et al. was whether teachers can adapt their teaching techniques to accommodate students with different cognitive styles. Related to this question is, what is the effect for both the teachers and the students if the teacher is sensitized to the inherent differences for field dependent and independent students?

Several pages of the Witkin et al. (1977) article were devoted to the conflicting research in the area of matching/mismatching with cognitive style. The researchers only commited to the fact that matching/mismatching with cognitive style was a factor in teacher-student interaction. An unknown variable was whether match/mismatch actually improved learning and, if so, how it improved learning. The researchers also noted that other situational variables (i.e., the study moderator) may have impacted the results on matching/mismatching.

Jonassen and Grabowski (1993) devoted an entire chapter of The Handbook of Individual Differences to the cognitive style of field dependence and field independence (a.k.a. global vs. articulated style). They summarized the research on the implications of the style characteristics as

> Instructional conditions that capitalize on the preferences of the field dependent student and challenge the field independent student include:
>
> 1. providing a synergogic (social) learning environment;
> 2. offering deliberate structural support with salient cues, especially organizational cues such as advanced organizers;
> 3. providing clear, explicit directions and the maximum amount of guidance;
> 4. including orienting strategies before instruction;
> 5. providing extensive feedback (especially informative);
> 6. presenting advance organizers (verbal, oral, or pictorial);
> 7. presenting outlines or graphic organizers of content;
> 8. providing prototypic examples;
> 9. advising learner of instructional support needed (examples, practice items, tools, resources);
> 10. providing graphic, oral or auditory cues;
> 11. embedding questions throughout learning; and
> 12. providing deductive or procedural instructional sequences (p. 97).

Instructional conditions that capitalize on the preferences of the field independent student and challenge the field dependent student include

1. providing an independent learning environment;
2. utilizing inquiry and discovery teaching methods;
3. providing abundant content resources and reference material to sort through;
4. providing independent, contract-based self-instruction;
5. providing minimal guidance and direction;
6. asking the learner to pose questions to be answered;
7. using inductive instructional sequence;
8. creating outlines, pattern notes, concept maps, etc.; and
9. using theoretical elaboration sequences (pp. 97-98).

These characteristics were used as guidelines for the development of the treatment used in this research.

## Awareness of Cognitive Style

A thorough review of the literature yielded no empirical evidence of the importance of awareness of cognitive style in the design of instruction. However, several researchers (Jones, 1993; O'Brien, 1989; Perry, 1994; Schmeck, 1988; Turner, 1993) suggested considering the importance of student awareness of their own cognitive style and what it means educationally. To date, it is merely a suggestion of value and has not been studied as a factor in research where any cognitive style, including field dependence/independence was a variable. These suggestions have an overall theme--that awareness of cognitive style may increase the ability to recognize that individual needs are not being met. Consequently, these subjects may want to take a substantial part in their own learning.

Schmeck (1988) stated that "placing limits upon self-knowledge ... may be what places limits upon overall cognitive integration. If this is so, then increasing self-acceptance will permit greater self-awareness and lead ultimately to a cognitive style characterized by greater versatility, flexibility, and adaptation in overall functioning" (pp. 149-150). In a situation where accommodation of cognitive style is not being considered, awareness of individual style could lead to self-adaptation to the environment or to the individual's request that the environment be altered to meet his or her needs. This may be critical in the case of the field dependent subject who needs a more structured environment yet finds himself or herself in a very unstructured learning environment.

Perry (1994) commented that if there was an understanding of cognitive/learning styles, cooperative arrangements could be made between individuals of different styles to possibly compensate for the deficiencies of one style. Perry also suggested that an appreciation for diversity was important in any educational environment. This extends beyond the diversity of race and gender to other ways of thinking and learning. According to Perry, when we allow learners to understand how they learn, there is greater possibility for efficient and effective learning and teaching.

Jones (1993) devoted an entire article to the question, "Cognitive learning styles: Does awareness help?" Jones suggested that cognitive styles had general applicability, lended themselves to cross-application over various subject matters; and had a broad usefulness which extended to other areas outside of education. "Due to the fact that the students learn something about their own mental processes, they may then be able to structure and make sense of otherwise unordered experience and of their intuitive or random use of procedures. This has great value in education, most particularly in self-study or independent learning" (p. 197).

Jones (1993) suggested that once a learner is aware of the characteristics for one type of cognitive style, the learner may be able to adopt learning strategies that will make use of their strengths and compensate for weaknesses. Finally, Jones concluded that it is not enough to make a student aware of these cognitive style characteristics; it is also important to include complementing instructional strategies which take into account these characteristics.

## Matching and Mismatching with Cognitive Style

Currently, little is known about the exact relationship between matching or mismatching students with their cognitive style and the cognitive style itself. Witkin et al. (1977) suggested that these questions be answered in future research: (a) whether matching for cognitive style makes for better student learning or is it simply that teachers and students with the same cognitive style like each other better? (b) if matching does make for better student learning, why does this occur? and (c) what other variables enter into the match/mismatch environment that may alter outcomes of such experiments?

Shipman and Shipman (1985) questioned whether researchers currently know enough about the match/mismatch variable to make exact determinations of instructional implications. Since the exact relationship is unknown, it is impossible to know whether either matched or mismatched results occur due to characteristics of cognitive style, interpersonal incompatibilities of students and teachers, inappropriate teaching techniques, or differences in personal interests which may be related to the traits of that cognitive style. Rather, Shipman and Shipman suggested that future researchers should either focus on the effects of the match/mismatch or on how to create environments that are adaptive to the needs of field dependent/independent subjects.

## Hypermedia and Cognitive Style

Hypermedia is a computer mediated environment which holds great promise for the accommodation of individual differences. Inherent in its special properties, hypermedia has the ability to be flexible or structured, provide varied feedback, and allow the user to access other resources at the click of a button. Ayersman and Minden (1995) acknowledged that there is little research regarding the relationship between hypermedia, learning, and accommodating individual differences. However, they suggested that hypermedia is the ideal way to accommodate a variety of individual differences, including cognitive style. The researchers stated that while other forms of traditional computer-aided instruction are available, other forms require that the instruction be modified or that the learner adapt to the instruction. Hypermedia, on the other hand, has "the ability to deliver information in contextually meaningful sequences, at a variable pace controlled by the learner, and through multiple sensory modalities" (p. 387). In other words, hypermedia can be developed to accommodate various learner needs.

Little research exists in the combined area of hypermedia, field dependence/ independence and the match/mismatch of cognitive style with instruction. However, two studies, both of which examine matching aspects of instruction which correlate to individual characteristics of cognitive style in computer aided/hypermedia aided instruction, will be discussed.

Weller, Repman, Lan, and Rooze (1995) conducted two studies which investigated: (a) possible mismatches between learners' cognitive styles (field dependence/independence) and the presence of advance organizers and structural organizers in the hypermedia, and (b) possible mismatches between learner's cognitive style (field dependence/field independence), social context of learning, and self-regulation of time during HBI (Hypermedia Based Instruction). Junior high subjects in both experiments used a computer ethics Hypercard stack and answered questions on a posttest. Both studies concluded that field independent learners had higher achievement scores overall but that differences in treatment options (the presence or absence of advanced organizers) impacted achievement for field dependent subjects but not for field independent subjects. "These findings suggest that designers of HBI [Hypermedia Based Instruction] should look for ways to take into account the users' cognitive styles. Perhaps hypermedia software should initially diagnose a user's cognitive style and then provide optional modes of interactivity depending on this learner characteristic" (Weller et al., 1995, p. 463).

A study conducted by Hedberg and McNamara (1985) examined the relationship between type of feedback and cognitive style. The researchers found:

1. Field dependent subjects had longer first response time, higher number of first response errors and higher total errors on the task;
2. Field dependent learners performed better when given feedback containing an explanation of errors and strategies for correcting errors, than when given only an indication than an error had been made;
3. Field dependent students reduced their response time and number of errors when given an explanation of their errors and strategies for solving the problems; and
4. Providing detailed explanations of errors and strategies for problem solving did not improve performance of field independent learners. Field independent learners took less time and made fewer errors when given only an indication that an error had been made ("That's not right...Try again").

## Research Design and Methodology

### Subjects

Since it was essential that the subjects have no prior knowledge of Hypercard, subjects currently enrolled in undergraduate technology courses were asked to volunteer for the study. Volunteers from ET 301 (Educational Technology Applications) were given extra credit to participate in the study and could choose to participate in lieu of attending class to learn Hypercard. Volunteers from ET 201 (Technology in Education) could choose to waive

either an assignment involving questions from the textbook or an assignment involving drawing packages, in addition to receiving extra credit.

Internal Review Board approval was given before conducting this study. Volunteers were required to sign a participant consent form prior to the treatment. After the treatment, if the subjects did not believe that they were successful in learning Hypercard, make-up sessions were offered. However, only one subject inquired about make-up sessions. This subject never followed up with a requested for a specific time.

## Instrumentation

### Group Embedded Figures Test (GEFT)

In order to determine whether students were field dependent or field independent, subjects were given the Group Embedded Figures Test (GEFT) during regular class time and were assigned a student number based on their social security number. The GEFT is an adaptation of the original Embedded Figures Test (EFT, developed in 1950) which has been used to determine field dependence/independence for large groups of individuals (Witkin, H. A., Ottman, P. K., Raskin, E., & Karp, S. A. (1971). This thirty-two item instrument has a correlation of -.82 for male undergraduates and -.63 for female undergraduates with the EFT (Witkin et al., 1971) . The Spearman-Brown reliability estimate is .82 (Witkin et al., 1971). The researcher hand scored the GEFT using a template provided by the publisher.

## The Hypercard Stacks

Two Hypercard stacks were developed by this researcher to teach Hypercard, a requirement of the second undergraduate educational technology course. The stacks were designed to assess the subject's knowledge of Hypercard, and to accommodate the special needs of field independent and field dependent subjects. The stacks were based on the Hypercard portion of the instructional packet already in use with current classes. This portion of the packet has been a part of the undergraduate educational technology courses since 1995 and has been updated regularly to correct errors and reflect changes in the curriculum and the software.

The hypermedia stacks were developed with careful consideration of the reported research in the area of field dependence/independence while still focused on the learning objectives. The accommodations for field dependence/independence were mostly in the area of instructional support, the structure of the instructional environment and feedback. The instructional environment for field independence had minimal structure--a menu from which subjects could choose to proceed through the stack in any order. Instructional support was also minimal and was provided only when the subjects sought support (e.g., clickable text, scripting help). Also, the field independent stack provided minimal feedback, only telling the student that he or she was incorrect as they proceeded through the learning task.

The field dependent stack was exactly the opposite. The field dependent stack was highly structured; subjects were required to complete the stack in sequential order before they were allowed to go to the next area. Extensive instructional support was provided; for example, definitions were repeated and users were informed of access to both this researcher and computer lab consultants. Feedback was explicit and corrective

Other than these specific accommodations, it is important to emphasize that the instructional content itself was identical for both the field dependent and independent stacks. This ensured that both groups received equal treatments. Also, both groups were allowed to take notes as notetaking was shown to be of benefit to both field dependent and field independent subjects (Frank, 1984). As stated earlier, both stacks were designed to meet the instructional objectives detailed in the instructional packet currently in use in undergraduate educational technology classes.

Before administration, the treatment stacks were evaluated by subject matter experts in three areas: Hypercard, field dependence/independence, and Educational Technology instruction to establish face and content validity. The subject matter experts examined the Hypercard stacks, checked the accuracy of the design both for content and accommodation of field dependence/independence, evaluated the assessment criterion, and recommended revisions on a printed copy of the stacks. Based upon these comments, revisions to the stacks were completed. This process was repeated until the stacks were accurate and complete.

## Achievement Rubric

The next part of the treatment involved application of the student knowledge. Subjects were required to complete their own stacks. They had one hour to complete a short stack which included all of the Hypercard

elements that they learned about during the treatment. They were allowed to use the notes that they took during the first portion of the treatment; no other support was provided. These stacks were graded for accuracy according to a predetermined grading scale based upon past Hypercard assessment criteria.

Students were assessed on the following criteria: (a) Hypercard stack created; (b) backgrounds included; (c) buttons included; (d) text fields included; (e) graphics included; (f) hyperlinks included; (g) "pop-up" items using the show/hide commands included; and (h) the overall content and instructional value of their stack. These stacks were graded by this researcher based upon preset point values for the stated criteria. Stacks were submitted with research participant number as the only student identification.

## Satisfaction Questionnaire

A satisfaction questionnaire was developed for administration at the end of the treatment. Questions were designed to determine if students were satisfied with the learning environment, were comfortable with the learning environment, and to self-assess learning from the experience. For every question, an equal and opposite question was written to ascertain which wording best asked the question to be answered (e. g., "I liked learning Hypercard via computer" vs. "I did not like learning Hypercard via computer"). Two statistical consultants evaluated the questions for face and construct validity. These questions were then pilot tested with a group of approximately sixty subjects and subsequently scored to determine how effective the instrument was at measuring satisfaction. Finally, the completed satisfaction instrument was subjected to a Cronbach's Coefficient Alpha and a factor analysis to establish statistical validity and reliability. Two of the initial twenty-one questions were dropped after the factor analysis revealed that these questions did not load highly on any factor and the Chronbach Alpha procedure revealed that dropping these questions increased the reliability coefficient. The resulting Coefficient Alpha for the satisfaction questionnaire was .89.

## Data Collection

Although two hundred eleven subjects originally took the GEFT, there was subject attrition and incomplete data from some participants. Therefore, the following reflects numbers of subjects whose information was used in the data analysis. One hundred seventy-seven subjects were divided into field dependent or field independent groups based on two factors: their GEFT scores and previous research (Thompson & Knox, 1987) which divides subjects based on the GEFT means for men and women. Since previous research (Witkin et al., 1971) indicated there were different means for males and females, collecting this data gave a more exact description of the sample and provided more accurate information for participant assignment to field dependent/independent groups. Ninety-four field independent and eighty-three field dependent subjects were involved in the treatment.

Once the subjects were divided into field dependent/independent groups, these groups were divided in half using a random number generator. Prior to treatment, one half of the field independent subjects (fifty-one) were made aware of their GEFT scores and the instructional implications of being either field dependent or independent. The other half of the field independent subjects (forty-three) had no knowledge of their GEFT scores and did not receive information about the instructional implications until after the treatment. Also, one half of the field dependent subjects (forty-one) were made aware of their GEFT scores and the instructional implications of being either field dependent or independent. The other half of the subjects field dependent subjects (forty-two) had no knowledge of their GEFT scores and also did not receive information about the instructional implications until after the treatment

In addition, one half of the field dependent/aware subjects (nineteen) were placed in a treatment with an instructional environment that was matched with their cognitive style while the other half (twenty-two) were mismatched with their cognitive style. One half of the field dependent/unaware subjects (twenty-two) were placed in a treatment with an instructional environment that was matched with their cognitive style while the other half (twenty) were mismatched with their cognitive style.

All volunteers signed up for a two hour time slot during which they received the treatment. All subjects were given a disk containing the Hypercard treatment specifically designed for that subject's assigned group. The subjects worked on the treatment independently and according to the specific requirements of that treatment. They had one hour to complete the treatment and one hour to complete the assessment. The assessment portion of the treatment consisted of the students developing a Hypercard stack on their own with only the use of notes taken during the treatment. At the conclusion of the treatment, the subjects were given a satisfaction questionnaire to

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determine their satisfaction with the learning environment, their comfort with the learning environment, and whether they learned from the experience.

## Analysis Procedures

Due to the multiplicity of independent variables (field dependence/independence, match/mismatch, awareness/unawareness) and dependent variables (achievement on the Hypercard stack and responses to the satisfaction questionnaire), a 2x2x2 factorial Multivariate Analysis of Variance (MANOVA) was used with the alpha level set at .05.

If a difference had been found in the overall model, individual univariate procedures would have been performed to identify differences in main effects as well as in the interactions between variables for both dependent variables. According to Stevens (1992), using univariate procedures provides the best power providing an alpha level of .05 is used.

## Analysis of Research Questions

This section is divided into a discussion of the data collected and the statistical procedures used in the analysis of each of the research questions. The research questions are restated, followed by an explanation of the data, a summary of the analysis and findings and a statement indicating the retention of the null hypotheses. Tables are presented to display the statistical data and levels of significance when appropriate. Since the dependent variables of achievement scores and satisfaction questionnaire scores were positively correlated (r=.5378), a Multivariate Analysis of Variance (MANOVA) was used for the statistical analyses. Achievement was measured using an achievement rubric. The results were obtained by scoring subject's individually created Hypercard stacks. Satisfaction was measured by obtaining a total satisfaction score based upon the answers to the satisfaction questionnaire.

## Analysis of the Independent Variables of Matching and Mismatching

$RQ_1$. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

$RQ_2$. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student achievement in learning Hypercard?

$RQ_3$. To what extent does matching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

$RQ_4$. To what extent does mismatching a student with a hypermedia environment designed with instructional support for field dependent or field independent cognitive style affect student satisfaction with the Hypercard lesson and the learning experience?

The results were obtained by calculating individual subjects' achievement and satisfaction scores and comparing these results in matched versus mismatched group. Results of the analysis are indicated in Table 1.

*Table 1*

*Results of the Multivariate Analysis of Variance using Wilks' Lambda for the Variables of Matching and Mismatching on Achievement and Satisfaction Scores*

| Source of Variation | Multivariate F-Ratio | Degrees of Freedom | p |
|---|---|---|---|
| Match/Mismatch(ma/ms) | .0669 | 2;164 | .9354 |

alpha=.05
significance indicated by *

The resulting MANOVA statistic of .0669 was not found to be significant for the overall model including the dependent variables of achievement and satisfaction. Thus the null hypotheses were retained. For this sample, subjects who were matched with an instructional environment with support for their cognitive style did not score significantly higher on either achievement or satisfaction than those who were mismatched.

## Analysis of the Role of Awareness

$RQ_5$. To what extent does awareness of field dependence/independence affect student achievement in a hypermedia Hypercard lesson?

$RQ_6$. To what extent does awareness of field dependence/independence affect student satisfaction with a hypermedia Hypercard lesson?

The results were obtained by calculating individual subjects' achievement and satisfaction scores and comparing these results for aware versus unaware groups. Results of the analysis are indicated in Table 2.

*Table 2*

*Results of the Multivariate Analysis of Variance using Wilks' Lamda for the Variables of Aware and Unaware on Achievement and Satisfaction Scores*

| Source of Variation | Multivariate F-Ratio | Degrees of Freedom | p |
|---|---|---|---|
| Aware/Unaware(aw/uw) | .0971 | 2;164 | .9075 |

alpha=.05
significance indicated by *

The resulting MANOVA statistic of .0971 was not found to be significant for the overall model including the dependent variables of achievement and satisfaction. Thus the null hypotheses were retained. For this sample, subjects who were aware of their cognitive style and its instructional implications during the treatment did not score significantly higher on either achievement or satisfaction than those who were unaware.

## Analysis of the Interactions

RQ7. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence) singly or in combination affect achievement in learning Hypercard?

RQ8. To what extent do these three variables (learner awareness of field dependence/independence, matching/mismatching Hypercard lessons, field dependence/independence) singly or in combination affect satisfaction with the Hypercard lesson and the learning experience?

The results were obtained by calculating individual subjects' achievement and satisfaction scores and comparing these results in the interactions between field dependent/independent, matched/mismatched, and aware/unaware groups. Results of the analysis are displayed in Table 3.

*Table 3*
*Results of the Multivariate Analysis of Variance using Wilks' Lamda for the Interactions on Achievement and Satisfaction Scores*

| Source of Variation | Multivariate F-Ratio | Degrees of Freedom | p |
|---|---|---|---|
| FI/FD x AW/UW | .0688 | 2;164 | .9336 |
| FI/FD x MA/MS | .0801 | 2;164 | .9230 |
| AW/UW x MA/MS | .4446 | 2;164 | .6418 |
| FI/FD x AW/UW x MA/MS | .4824 | 2;164 | .6182 |

alpha=.05
significance indicated by *

The resulting MANOVA statistics were not found to be significant for the overall model including the dependent variables of achievement and satisfaction. Thus, the null hypotheses were retained. For this sample, interaction effects between the independent variables of field dependence/independence, matching/mismatching and aware/unaware were not found to make a significant difference in achievement or satisfaction scores.

## Other Data Analyses

Although the statistical procedures defined by the research design and methodology were used, statistical significance for the hypotheses was not obtained. However, it may be important to document other types of descriptive and qualitative data for further research.

## Means and Standard Deviations

There are times when using advanced statistical procedures yields little in the explanation of what occured during data collection. Therefore, an examination of means and standard deviations may document the potential for any unsubstantiated group differences. These descriptive statistics are listed in Tables 4 and 5.

*Table 4*
*Means and Standard Deviations for the Dependent Variable of Achievement*

| | Achievement | | |
|---|---|---|---|
| Group | M | SD | n |
| FD/AW/MA | 5.1842 | 2.1616 | 19 |
| FD/AW/MS | 5.0000 | 2.3350 | 22 |
| FD/UW/MA | 5.3409 | 1.9844 | 22 |
| FD/UW/MS | 4.1000 | 1.8680 | 20 |
| FI/AW/MA | 4.6875 | 1.9826 | 24 |
| FI/AW/MS | 4.5909 | 2.7802 | 22 |
| FI/UW/MA | 4.9815 | 2.1505 | 27 |
| FI/UW/MS | 5.9048 | 2.3644 | 21 |

*Table 5*
*Means and Standard Deviations for the Dependent Variable of Satisfaction*

| | Satisfaction | | |
|---|---|---|---|
| Group | M | SD | n |
| FD/AW/MA | 46.6111 | 17.3651 | 19 |
| FD/AW/MS | 46.8571 | 16.9035 | 22 |
| FD/UW/MA | 40.9090 | 15.3837 | 22 |
| FD/UW/MS | 41.6500 | 14.4086 | 20 |
| FI/AW/MA | 44.5000 | 14.6495 | 24 |
| FI/AW/MS | 44.0682 | 18.1267 | 22 |
| FI/UW/MA | 45.5185 | 14.0757 | 27 |
| FI/UW/MS | 53.4048 | 17.2740 | 21 |

The overall means in the case of this treatment were low, both for achievement and satisfaction. However, all eight groups had individuals with higher scores, middle range scores, and lower scores. Note that the means and standard deviations are similar for all groups. There may be other variables affecting achievement and satisfaction different from the independent variables analyzed in this study.

## Analysis of Qualitative Data

Although the quantitative data indicated non-significant results, the qualitative data obtained via the open-ended question on the satisfaction questionnaire and from post-treatment conversations with subjects yielded important information. A number of field dependent subjects indicated that they believed it was important for them to have extensive instructional support with step-by-step instruction (a few subjects directly quoted the field dependent/independent information given to them during the instruction). Several of the subjects who were mismatched with their instructional environments were very upset by this mismatching and confessed they were confused and frustrated. Those who were aware of the instructional implications of being field dependent questioned why they were not given a treatment with more support and directions. Those who were unaware of their cognitive style blamed themselves for their failure--many stating that were "no good at timed tests" or were "stupid." The most outspoken subjects seemed to be in the field dependent, unaware, mismatched group.

On the other hand, the field independent, aware, mismatched group was also more outspoken than subjects in other groups. The comments for the field independent subjects differed greatly from those of the field dependent subjects. Comments made by this group included such things as "the instruction was too easy--I thought Hypercard would be easy," and "it drove me crazy to go step-by-step like that--I just got through the instruction as soon as possible." These subjects had a tendency to blame external sources for their perceived lack of success. Note taking was commonly cited as a problem for this group. Subsequent review of notes indicated that the subjects actually took little if any notes and did not write down information specifically mentioned as important for their ability to create their own stacks during the second part of the treatment.

There were some other interesting overall trends pertaining to field dependent versus independent subjects regardless of awareness or matching. Many field dependent subjects suggested their perceived failure on the task was due to human-centered difficulties with the treatment. Several suggested that they needed more support from the *instructor*, not the computer. One subject made the statement that it was important to learn via a social learning environment (quoting information given during the treatment); from human beings--not a computer.

Field independent subjects seemed to desire more access to external resources. These subjects seemed to like learning via computer but would have preferred to be able to ask questions of the researcher during the second portion of the treatment. The qualitative information seems to be in agreement with researchers such as Goodenough (1976).

## Discussion and Suggestions for Future Research

The results of this study, in conjunction with the results from other studies, do not support conducting additional quantitative research to measure complex, interrelated dependent learner variables. Separating subjects into groups in order to isolate variables did not yield as much useful information as did the free response data collected with the satisfaction questionnaire. Future researchers should concentrate on qualitative methodologies to

examine how individuals interact with learning environments. In the next section, suggestions for future research will be discussed.

## Qualitative Research

This researcher believes that it is important to conduct qualitative research concerning the ways in which field dependent and field independent individuals interact with learning environments. As previously mentioned, although it was specifically stated in the initial instructions that they would be receiving their results during the treatment, why were the vast majority of subjects who claimed they did not receive their results field independent? Is there something instructors can do to "force" field independent subjects to read important information during independent learning tasks? Did the subjects not listen to the instructor or read the information because they perceived it to be irrelevant to the learning task at hand? These are questions which may be answered by future research.

For field dependent subjects, is it possible for them to learn and to feel comfortable in an independent, computer based learning environment? Many field dependent individuals commented on the satisfaction questionnaire that they would have been more successful had they learned from a "real" person (not a computerized treatment). Although the treatment was structured to include the adaptations for cognitive style during the instructional portion, subjects worked through the Hypercard treatment on an individual computer. There was no group/social interaction.

Future researchers might want to consider designing an environment with extensive resources and observe how field dependent/independent subjects select those resources. Also, they should investigate which resources are important to learners and if resource selection varies by degree of field dependence/independence. However, to be effective computer based instruction (CBI), extensive front-end analysis, formative evaluation, as well as special design considerations are required. This is not always practical for a single individual to attempt in their own classroom. Instead, including resources such as a live instructor, print materials or other media from an outside source, or peer tutors, in addition to the CBI may be a practical and cost effective way of designing learning environments which support both field dependence/independence.

## Cognitive Restructuring

Witkin & Goodenough (1981) discuss "cognitive restructuring" -- the ability of some individuals to restructure the field depending upon the task. After this current treatment, several individuals confided in this researcher that they did not believe the information regarding their Group Embedded Figures Test score fit them at all. Upon further examination, many of these individuals had GEFT test scores which placed them along the mean. Thus, these individuals were neither strongly field dependent nor strongly field independent. The individuals were then asked whether or not they believed the information fit them when interacting with any learning environment. The majority of individuals said that in some cases the information reflected the ways in which they usually learned but definitely not all the time. In the future, it might be important to determine to what degree individuals whose GEFT scores fall along the mean are able to change learning strategies and under which conditions they make this change.

## Job Related Cognitive Style Information

Although many studies have shown field independent individuals to outperform field dependent individuals regardless of the task (e.g., Bishop-Clark ,1992; Frank, 1984; Jonassen, 1980), there may be other factors which impact performance, especially on the job. Factors such as missed deadlines, absenteeism and the ability to follow directions might have as great an impact on job performance as the overall quality of one's work. This point is mentioned because at one point during the ten days over which the treatment was conducted, field independent subjects were four times as likely not to take the treatment during their originally scheduled times as field dependent subjects (actual numbers: 3 to 12). It might be of interest to future researchers to examine the role of field dependence/independence on overall job performance.

## The Perfectionist Factor

Although achievement and satisfaction were shown to be moderately correlated overall, there was a select group of subjects (twenty-eight) for which this was not the case. For these individuals, a fairly high achievement (7.5 or greater) was paired with a very low satisfaction score (50 and below). Upon further examination of the

satisfaction questionnaire data about the reasons they did not believe they had satisfactorily completed the task, many of these subjects indicated that they were unable to accomplish some small portion of the overall instructional goal (e.g., "I could not do pop-ups" or "I could not get my quit button to work"). It did not appear to this researcher that there was a pattern to the characteristics of these subjects. It might be important to consider why these individuals were so dissatisfied with a better than average performance.

## The Design of Hypermedia

Empirical results indicate that making subjects aware of their cognitive style and matching or mismatching them with instruction embedded with support for cognitive style did not make a difference for this sample. Comments from students may be important in the design of future hypermedia environments. This researcher has the following suggestions related to the use of hypermedia learning environments:

1. Many subjects may need additional support regardless of cognitive style when completing complex tasks.

2. Support does not always correlate with structure. Many field independent subjects did not like the structure of the field dependent treatment. They would have liked to ask questions of the researcher.

3. Providing plenty of resources, according to Jonassen and Grabowski (1993), may be important for field independent subjects. However, it may also be important to provide similar resources for field dependent subjects. For example, including suggestions for instructional paths in a hypermedia environment which can be printed would provide another "resource" for field independent subjects and provide "structure" for field dependent subjects.

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